METAL BUILDING CONSTRUCTION

USING THE MIC-240 ABM K-SPAN MACHINE

by

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In writing this report there are several people that must be recognized for there significant contribution to the fulfillment of my life. I must thank my wife Ileana for two things that come to mind right away. First for her unwavering support which has helped me through this year, and secondly for giving birth to our daughter Tatiana. I must also thank my parents Claude and Patricia Roye for their contribution as great parents without which I wouldn't be here. Many, many, many, Thanks!

ABSTRACT

The process of constructing a metal system has always been fairly similar to construct. Although there are many companies that produce, manufacture, and construct metal buildings, the construction effort has been the same. The typical steps are to construct the foundation and floor slab, then erect the steel columns, and roof beams. Once this was completed, the next step was to add Purlins and joists. The final step was to attach and seam together the roof system.

There is a different type of metal building system called a K-Span. This metal building does not follow conventional metal building construction methods. In order to construct a K-Span metal building, a special K-Span machine is required. With this machine, a K-Span seamer, and coils steel stock material, a metal building can be constructed. The folks at M.I.C. Industries have taken a different approach to construction of metal building systems by producing a machine that bends, corrugates, and produces curved panel that acts as a structural members not requiring steel columns or steel beams for internal structural support. These curved panels once seamed together, produces a unique, complete and usable metal building.

1. OBJECTIVE

The purpose of this report is to introduce a new type of metal building called a K-Span, although it's been around for many years, It is not as widely known in the civilian sector as Butler buildings. The K-Span Building has been the standard military utility building that serves as offices buildings, Hangers, and storage spaces in the field.

The final part of this report will entail a comparison and a contrast to the more famous Butler buildings using a simple K-Span storage building with a similar storage Butler building.

2. INTRODUCTION OF METAL BUILDINGS

Metal building systems have become the conventional method for construction of commercial or industrial buildings in the United States. In the past two decades, metal building systems sales have become the major market player in low-rise non-residential buildings of up to 150,000 sq. ft. in floor space. This is the primary market for metal buildings. Today's metal building system are representative of banks, showrooms, offices, shopping centers, free standing retail stores, and a broad range of service structures, as well as industrial and institutional application. (Metal Building Manufactures Association booklet)

Advances in technology along with new construction techniques have made today's metal buildings compatible with ordinary construction

materials such as: glass, brick, masonry, and wood. These metal buildings also offer a wide range of sizes and shapes from dynamic expanses of glass to brick fascias are becoming more popular. Metal building systems first emerged in the 1940's as a new and distinct method of construction. Metal building systems are sold by manufacturers to licensed contractors who design and construct the buildings for customers. This concept of the contractor designing and ultimately constructing the metal buildings has grown into what we consider a design-build concept. The benefits are far reaching, for it eliminates the mis-communication and finger pointing between designer and contractor when something goes awry because in a design-build environment designer and contractor are one in the same.

Advantages in the speed of construction and the economy have made the metal building system a preferred method of construction in the commercial and industrial applications. A metal building system consists of a series of factory manufactured components. These components include: Primary and secondary framing, roof, wall, and accessory subsystems. Once the factory has manufactured these systems, they are shipped to the local metal building system contractor for construction. Using state of the art techniques and precise in-plant manufacturing equipment, manufacturers can produce elements that are sheared, punched, and precisely shaped by matching to the customers exact specification. The components of the metal building system are designed together as a system to work together

supporting, and forming a building structure that meets design specifications, code requirements, locks out weather and limits heat gain and heat loss.

3. INTRODUCTION OF BUTLER BUILDINGS:

Butler manufacturing has been around for many years, and they have cornered the market on sales today. The company has developed a research center that constantly tests new materials from steel and coatings to the less obvious fasteners and sealants. Metal buildings today are so esthetically advanced there is no visible difference between typical conventional concrete, or brick buildings. One major reason is for the use of brick fascias, concrete masonry unit block walls and huge expanses of glass. See example figure below:

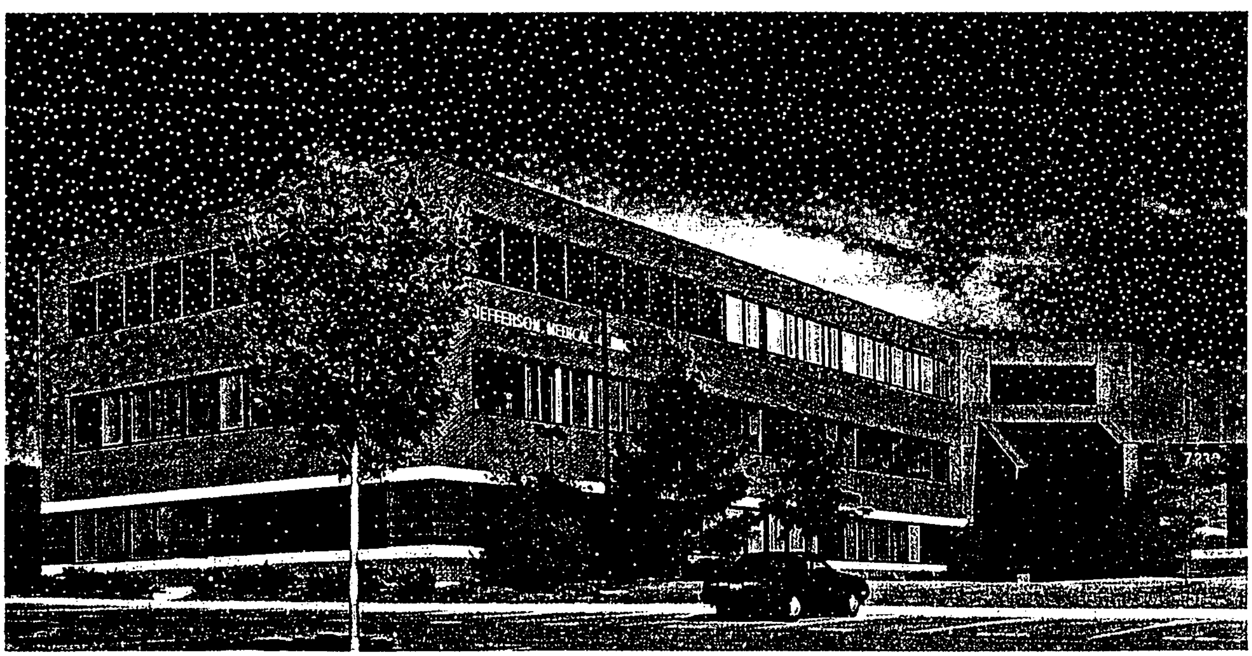


Figure 1: Example of metal building with brick fascia

4. CONSTRUCTING A TYPICAL METAL BUILDING SYSTEM

For this report a simple Butler storage building will be used for comparison with a K-Span. Butler buildings like any other metal building begins with the foundation and slab. Since a simple Butler metal building will be used for comparison, the walls which can be brick or CMU, will be metal in order to save on the construction cost. The next phase of constructing the Butler building will be to erect the columns and roof beams using steel members. This is accomplished using a crane to get the members in place. The roof beams and the wall columns are bolted together in place.

Steel metal girts are then bolted in place approximately half the distance up the walls columns. These girts are to provide stability and support the corrugated wall metal sheets. The walls are constructed of 36 inch wide 1 1/2 inch corrugated metal sheets, .035 inches thick called the "Butlerib" wall system. These corrugated wall metal sheets are then bolted to the girts for rigidity. The entire wall system of 36 inch panels each will be seamed together to form a rigid wall system. See the figure below.

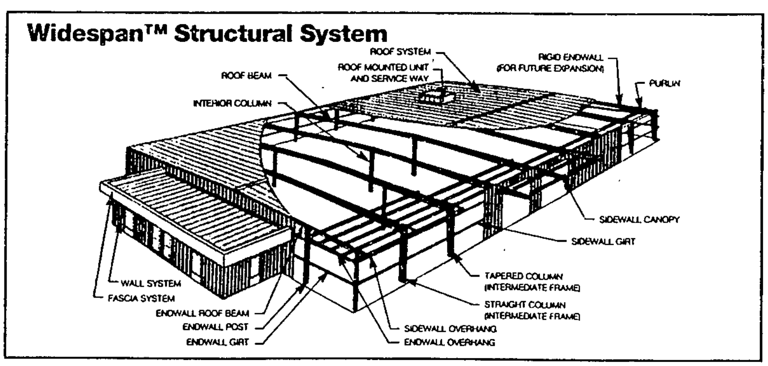


Figure 2: Example cut-away of typical metal building

Roof purlins will then be erected and tied into the roof beams. The final stage of the roof system is the corrugated "Butlerib" MR-24 roof system. The roof system is constructed the same as the wall system and seamed together similarly also. Butler manufacturing has developed the modern single membrane floating monolithic metal roof system called the CMR-24. The CMR-24 roof system is seamed together and once seamed, is considered to be monolithic. This system uses a 360 degree double lock seam. See example figure below.

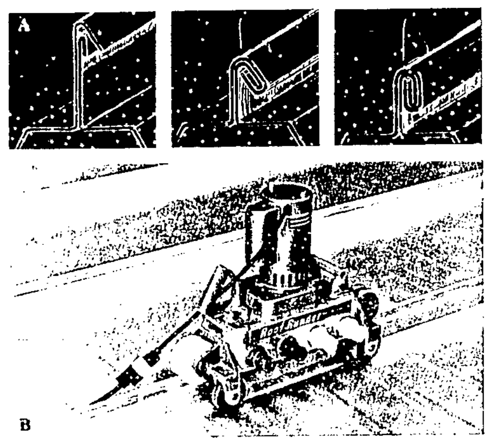


Figure 3: Picture of 360^0 double lock seam and seamer

Roof clips securely attach the roof panels to the supporting structural by stainless steel tabs which are roll formed into the panel seams. Stainless steel tabs are more than 50% stronger than other galvanized standing seam tabs. The clips allow for 1 1/2 inch travel to accommodate expansion and contraction of the metal roof. This permits buildings up to 500 ft. wide without special expansion joints. The MR-24 roof system is available in 24

and 26 gage aluminum/zinc coated steel. There is a special coating of fluoropolymer called Butler-Cote 500 FP which contains 70% Kynar 500/Hylar 5000 resin. See figure below:

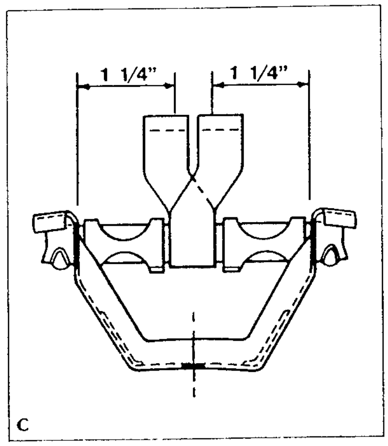


figure 4: Special roof clips designed by Butler Manufacturing Company

Butler has also perfected the delta truss system which works well with roof system requiring ventilation. The delta joist system provides a space in the center of the truss for ventilation ducting. See figure below.

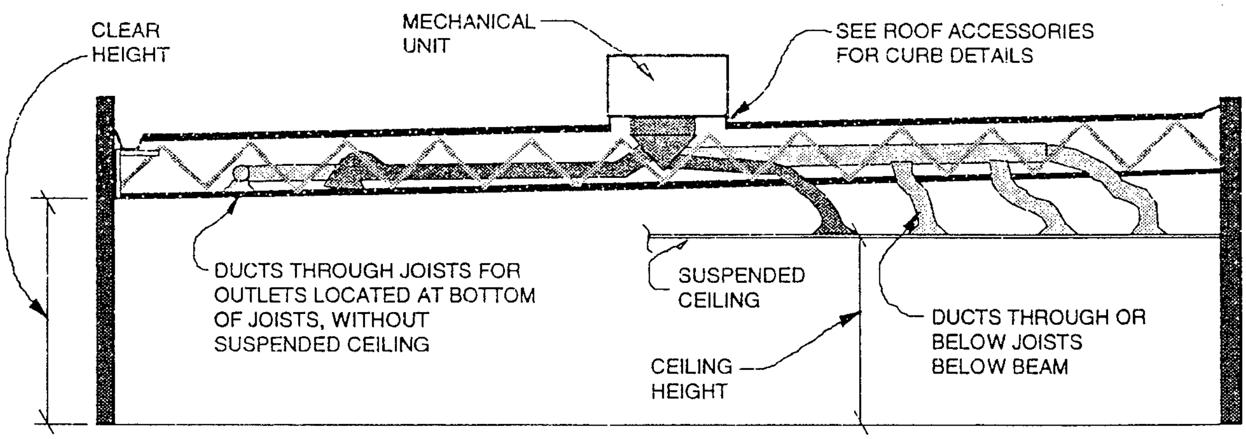


Figure 5: Example of Delta truss roof system

5. INTRODUCTION TO K-SPAN

MIC industries, the manufacturers of the K-Span, has made it simple to construct pre-engineered buildings by designing a machine that can change the size of your building with the touch of a button, and requires the bare minimum in the way of construction material, coil steel. The construction process will be discussed later in this chapter.

MIC Industries have designed two automated building machines for construction of Pre-engineered buildings. They are the MIC-120 and the MIC-240. The two machines are identical in every way except the MIC-120 produces a corrugated panel one foot in width and the MIC-240 produces a panel twice that size (two feet in width). Appendix A shows K-Span equipment specs.

Military applications and use of this type of building have been tested and have worked very well. Military commanders can benefit from a low cost (less than twenty thousand dollars) aircraft hanger, storage or utility building that requires little to no planning for construction. Transportation of these machines can be accomplished by land, sea, or air.

6. CAPABILITIES:

The MIC-240 ABM is capable of constructing a building as small as 48' wide by 18' high to as large as 120' wide by 40' high with an unlimited length. A trained crew can construct 10,000 square feet of building space

per day. Navy "Seabee" Battalions and the Air Force "Redhorse" Battalions are capable and trained for such in-the-field construction.

7. CONSTRUCTION

Step 1. Choosing a construction site. A major consideration is the slope of the terrain. If the slope is too great then construction problems can arise. This is due to the weight of the panels bending or distorting the shape of the curved sections to the point where it is impossible to assemble the building.

An important caution is to beware of overhead electrical wires. See an illustration below for an example of a level foundation site. OSHA standards requires the crane to have a clearing of at least twenty feet from electrical wires. Utility access is also a consideration for choosing a site. Water, electrical , phones, natural gas, are all possible utilities to use in the building. See appendix E and F for a typical jobsite layout. The K-Span building sits on angled steel which is part of the foundation. See below for a typical jobsite.

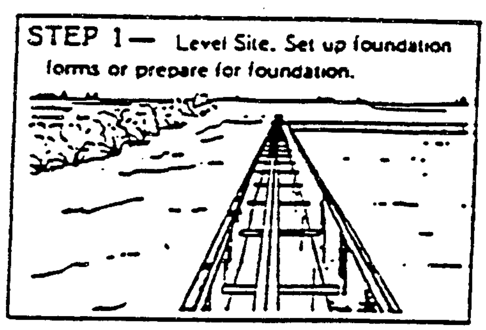


Figure 6: Foundation layout for K-Span

Step 2. Coil steel is then mounted on the MIC-240 ABM. The P-240 tables are placed and the coil steel is processed through the straight panel side onto the tables. See appendix G and H for further details. The illustration below also shows this operation.

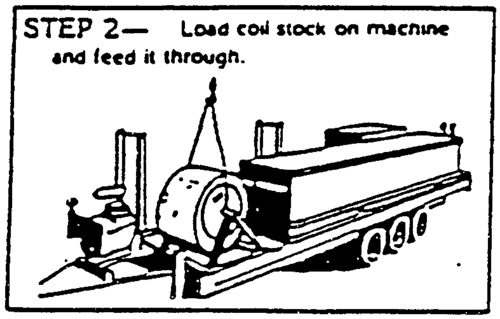


Figure 7: Set up K-Span machine

Step 3. The coil steel is then fed through the P-240 section and the corrugated straight panels are formed. See illustration below.

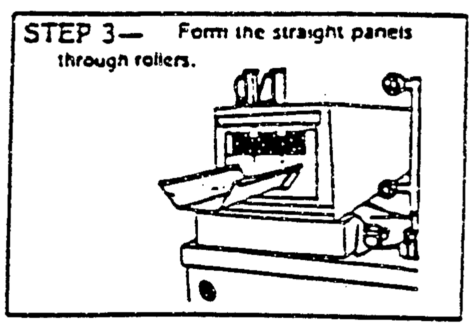


Figure 8: Forming straight panels

Step 4. Next, the automatic stops should be adjusted on the P-240 tables so the panels are stopped at exactly the right length. A mark should be made

on the tables where the tabs for the overhead lights are to be placed. Appendix I and the below illustration shows this procedure.

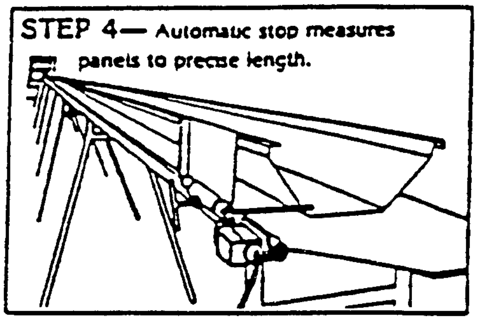


Figure 9: Automatic stop of straight panels

Step 5. The panels are then cut to the desired length using the hydraulically powered guillotine cutter on the K-Span machine. Appendix I and the below illustration shows this procedure.

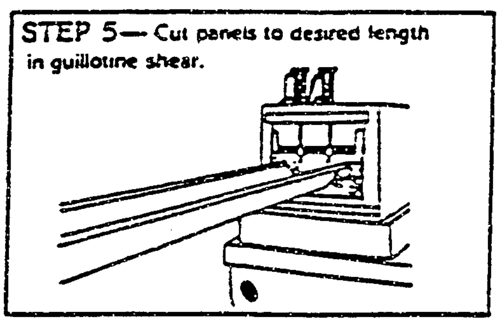


Figure 10: Cut straight panels at desired length

Step 6. The straight panel is then turned onto its side and slid over to the curved side entrance and it is then run through the C-240 machine. The illustration below shows this procedure.

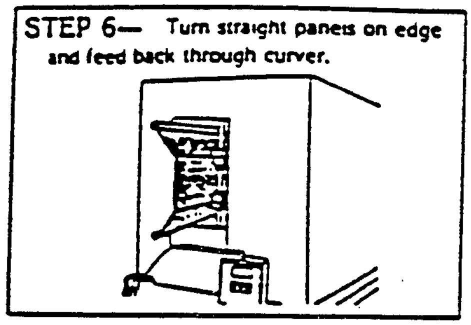


Figure 11: Feeding straight panels through curve side of machine

Step 7. The curved panels produced from the C-240 tables are lifted off the tables and staged on the ground in an assembly area. This step requires some muscle. An average of fifty pounds per person is recommended for this step. For a panel weighing five hundred pounds, ten personnel should be used (Appendix J illustrates panel weights). New sections are clamped together so the R-240 seaming machine can seam the sections of three. See appendix K and L and the illustration on the following page for the procedure.

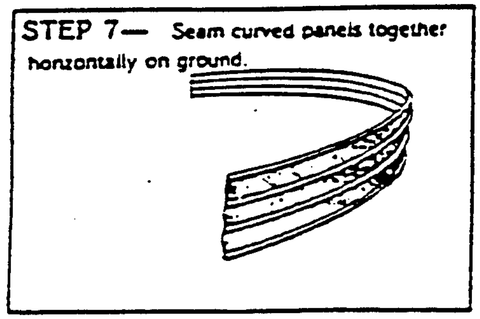


Figure 12: Seaming of curved panels together

Step 8. With the crane crew in place, a special panel lifting rigging device (Appendix M) is attached and the sections are hoisted by crane onto the angled steel on the construction site. See appendix N and the illustration below.

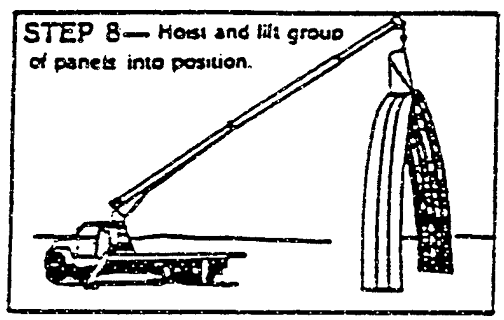


Figure 13: Hoisting groups of panels into position with a crane

Step 9. Once the first panel is hoisted in place by the crane, guy ropes attached to the panels are secured. The next section is then hoisted, and the two sections are seamed together. Appendix O and P along with and the illustration below.

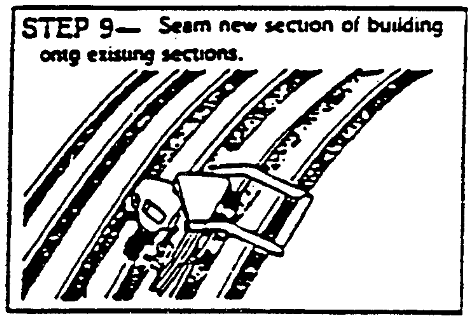


Figure 14: Seaming new sections onto existing sections

Step 10. The panels are then tack welded in place to the angled steel. The steel is not very thick, so caution should be taken not to burn through the steel during the tack welding process. The illustration below shows this step.

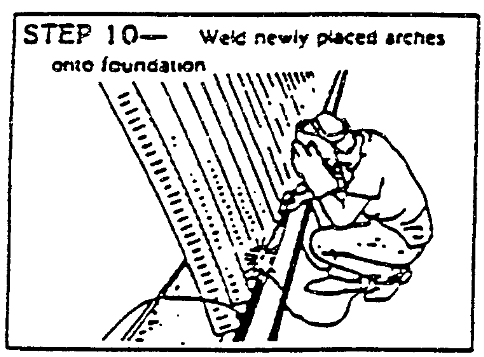


Figure 15: Tack welding new sections to foundation angle steel

Step 11. Once all the curved panels are in place, the end walls are then constructed, placed, tack welded and cut to fit the curved panels. Appendix Q and the illustration below shows this procedure.

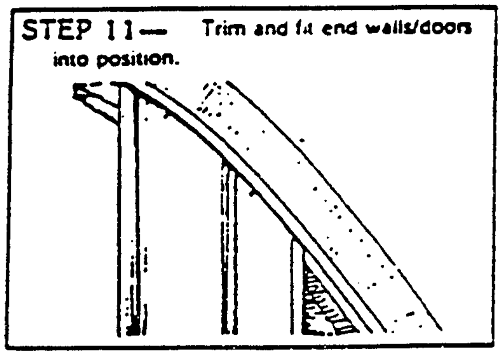


Figure 16: Trimming and fitting end walls

Step 12. Once the end walls are completed, concrete is then placed into the forms. Appendix R and the illustration below shows this procedures.

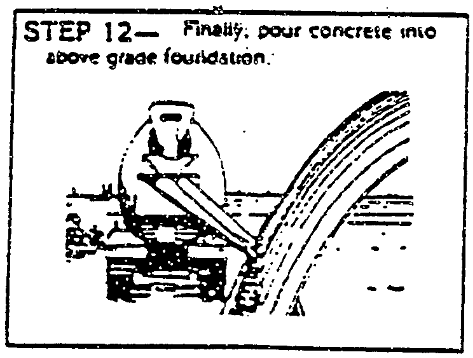


Figure 17: Placing concrete into foundation

The crew size for construction of the example building listed in appendix J is as follows:

TABLE 1:

	MINIMUM Crew members	IDEAL Crew members	FUNCTION Description of functions
	1	1	MIC-240 ABM operator
	4	6	Move straight panels to curved side table
	10	10	Lift curve panels to staging area
	3 from above	3	Clamp and seem sections of three
	4	4	Guy rope holders
TOTAL	**19**	**24**	

8. PERFORMANCE CHARACTERISTICS:

The MIC-240 ABM has three major components to the system; #1 The P-240, otherwise called the straight panel machine; #2 the C-240, otherwise called the curved panel machine; and #3 the R-240 seamer. Both the P-240 and the C-240 are powered by a diesel engine with a chain drive and hydraulic controls. The R-240 is an electric powered seamer that can take either 110volts or 220 volts and 9KW. The P-240 and the C-240 can

produce panels at the rate of sixty linear feet per minute, while the R-240 seamer produces thirty linear feet of seamed panels per minute. The production capabilities of the K-Span machine is limited by the seamer. One way to overcome this problem is to get an additional seamer.

Other performance limiters to the K-Span machine is the effects of the weather. The weather can affect production. For example, very cold weather can cause start up problems for the diesel engine. Extremely hot temperatures can also produce problems for the construction crews. Excessively high winds can create a problem for the crane erection crew. With the right wind speed and direction, the panel section can act as a sail and lift the guy rope handlers off the ground. As a result, construction is limited by wind speeds of less than twenty miles per hour. Usually the crane has more stringent requirements for operating it in high wind conditions than does the MIC-240 ABM.

9. SAFETY:

Typical construction clothing is required in order to use the MIC-240 ABM. These include a hard hat because of crane operations hoisting very heavy paneled sections overhead and into position. Steel toed boots are also required for the same reason as the hard hat requirements. Any one of these steel panels weigh in excess of four hundred and fifty pounds, so accidentally dropping a panel on someone's toe could leave them with serious problems.

Common sense dictates to wear a steel toed boot. Since the panels are made of steel, handling these panels requires gloves. The edges of the steel are quite sharp and could easily cause serious serrated cuts if the crew is careless and not paying attention. The seamers are crimping devices that pull two panels together and seams them. As a result, it is recommended that gloves should not be worn during seaming because they could get caught and pull the fingers into the seamer, creating serious injury. See appendix B for additional safety requirements when operating the MIC-240 ABM.

10. ENVIRONMENTAL:

There are no toxic substances or hazardous materials used in the MIC-240 ABM K-Span machine. The diesel fuel used to operate the engine can be filled on the job site. Any spillage of the diesel fuel requires clean up and disposal in an environmentally sound manner.

11. LIST OF ITEMS FURNISHED:

See the following page for a list of items furnished with the MIC-240 ABM K-Span machine. Appendix C also lists additional items.

TABLE 2: List of required equipment for K-Span

1. MIC-240 ABM (Super Span) Mobile Manufacturing System Consists of:			
1	P-240 Panel Forming Machine	1	9kw 110/220 Volt electric generator
3	R-240 Panel Seaming Machine	1	Lunette eye hitch
1	C-240 Curving Machine	1	Pintle hitch
1	T-240 Trailer w/ one (1) spare wheel and tire	1	Hand crimper assembly
22	Runout tables with adjustable legs and connectors	4	Panel attaching brackets
1	Spreader bar and lifting cable assemblies	1	Panel measure assembly w/125 ft. cord
1	Diesel engine	1	PC-240 Power Crimper
2	Operating manuals	1	Vinyl full machine cover
7	Vinyl covers		
1	ABM Foundation Forms Set, 600 linear feet		
2. Model KE-440 (110 volt) metal cutting power shears with 5 each blade kits			
3. Adjustable 9R vise clamps (50 each)			

12. SHIPPING, HANDLING AND STORAGE:

Air shipment can be accomplished by military aircraft such as: C-130 Hercules, C-141 Starlifter, C-5 Galaxy, or the new addition to the Air Force cargo fleet, the C-17. Other modes of transportation, such as by sea can also be accomplished. Hitching this trailer mounted construction machine to

the back of a typical troop transport (two and a half ton cargo truck) can also be a mode of land transportation. Containerized loading in a standard forty by ten foot container can also be accomplished. See Appendix D. Shipping should be done with the coil steel mounted so the rollers are prevented from hitting each other and causing damage. Once at the final destination, the steel can be removed. If the machine will not be used for a long term, then it is best to store it indoors out of the elements; however, if this is not possible, the machine should be covered with a vinyl cover. Start the machine every ninety days and let it run at operating temperature. Also, run through the hydraulic levers and controls. It is best not to have fuel in the tank if storage is for a long time; therefore, run the engine until it is out of fuel. Finally disconnect the battery.

13. K-SPAN PROBLEM AREAS:

Lack of proper corrosion prevention can cause several problems: An example of this is rusting at the of the edges of the seamed panels. This is due to an inadequate paint peeling or flaking off the steel at the seams and exposing the steel to inclement weather. This is due to the steel coils not being treated correctly with a rust or corrosion preventative during the manufacturing process. Another problem is the lack of corrosion preventative on the angled steel. Although the angled steel is inside the concrete foundation, rust can occur in a corrosive rich environment such as

near the ocean and bleeding of the rust to the surface of the concrete will cause additional rust to start at the base of the curved panels. Both examples can lead to structural problems, but with adequate treatment of the steel and a good paint preservation program these can be overcome.

14. K-SPAN SUMMARY

Although the K-Span building is quick and easy to construct at a very low cost, there are several problems that accompany steel buildings that can lead to structural problems. These problems include corrosion, but they can all be prevented by proper manufacturing techniques and an aggressive paint preservation program.

On the other hand, there are several benefits to constructing the K-Span building. One of these is the mobility of the K-Span machine and the minimal amount of materials required for construction. These make the K-Span buildings very suitable for the military or for a rapid construction requirement application. Uses are limited only to the imagination. Some of these include an aircraft hanger, a storage building or a utility space. The MIC-240 ABM can produce a building as small as forty eight feet wide to one hundred and twenty feet wide with an unlimited length. The machine can produce 1,500,000 linear feet of panels before it requires major replacement of parts. Although the limiting factor is the coil steel material, with an adequate supply, the major benefit of the K-Span building over other

metal buildings is realized because there are many different building size variation in which a touch of a button can produce, and no structural engineer is required to perform calculation.

15. DESIGN SPECIFICATIONS OF A UTILITY SPACE

For a comparison between both buildings a designed spec listed below is used. The objective is to determine the cost of the shell of a building. This means without lights or doors or any other frills. The comparison will be based on the shell of a building, and nothing else. for the following specifications

- 70 mile per hour wind load
- Live load of 12 PSF
- 4000 square feet of usable storage space
- No Utilities
    - Lighting
    - Water
    - Phones
    - HVAC
- Provide a ten foot opening for a roll-up door
- Door opening must have 18' eave height
- interior must be clear span

16. COST COMPARISON OF K-SPAN & BUTLER BUILDING

TABLE 3: Cost comparison

	BUTLER BUILDING	K-SPAN
Direct Cost	18,342	12,550
Overhead (12%)	2,201	1,506
Profit (6%)	1,232	843
Price	$21,776	$14,900

Again, the cost comparison shown above is for the shell of a building with no lights, doors, or ventilation. Any item that is required for both buildings was eliminated from the design specifications. The objective is to determine the actual cost of the shell of a K-Span building and compare it to the actual cost of the shell of a Butler buildiung. For the simple Butler storage building the final price is approximately 1.5 times as much as the K-Span building. Further breakdown of the direct cost could not be attained. As a result, the only comparison to make is the final direct cost. The Butler building structure can also include insulation, which is not an option for the K-Span building. The insulation would add a cost of $3,036.

17. COMPARISON

The Butler building is the top of the line when it comes to metal buildings. The Butler manufacturing company has researched and developed roof systems and delta trusses in order to produce a building that is sophisticated and pleasant. Butler's metal building system also works well together with brick, glass, and CMU to make an architecturally beautiful structure. Butler buildings are the way to go if the building desired is to function as an office building or industrial building, but if the building is to function as an unsophisticated storage building or a simple utility space, then the K-Span is a viable alternative. As shown in the cost breakdown section, the K-Span is indeed a less expensive alternative.

The K-Span which has been shown to be a versatile structure consists of the bare minimum in the way of construction material coil steel stock. Butler buildings require internal structural components such as: Steel columns and beams along with the corrugated steel metal sheets. The corrugated sheets in the Butler building are thinner than the K-Span because the sheet steel does not function as a structural member as in the K-Span building.

K-Span does not require a manufacturing plant to fabricate the building and ship it to the construction site for assembly like the Butler building. The K-Span is already designed for many different sizes in the technical manual. All that is required is a selection of the building size, the

touch of a button the change the size of the panel lengths, and finally, to construct the building. As a result, the K-Span is more versatile of the two buildings.

Appendix A: Provides a detailed list of equipment and specifications for the K-Span machine. The list includes dimensions of the machine, engine requirements etc. Appendix A is listed on the following page.

APPENDIX A

MIC-240 SUPER K-SPAN EQUIPMENT SPECIFICATIONS

Dimensions	: 35'7"
Width	: 7'6"
Height	: 7'10"
Deck Height	: 2'11"
Deck Area (width x length)	: 7'4" x 30'0"
(*)Weight (gross) lbs.	: 25,300 lbs.

Construction: Welded steel and precision machined parts (trailer, deck former, curver, run out table and seamers)

Axle	: 3 @ 7,000 lbs.
Battery	: 420 AMP, 12 Volt DC
Brakes	: Air over Hydraulic
Drive System	: Hydraulic
Power Plant	: Diesel 3 Cylinder 38 H.P.
Fuel Tank Capacity	: 12.2 U.S. gallons
Paint	: High grade industrial finish
Tires	: 950 R x 16.5 - "E" Range
Wheels	: 16.5 x 6.75

Miscellanous tools/spare parts: Generator 110/220V, electric and manual tools as well as miscellaneous spare parts supplied when applicable or as an option at extra charge.

(*) Steel coils not included in the gross weight.

The right is reserved to make changes at any time, without notice, in prices, colors, materials, equipment, specifications and models. Check with M.I.C. Industries, Inc. for up-to-date information.

Appendix B: Provides a list of safety features and precautions to use when working with or around the 240-ABM machine at the construction site. This should be studied and followed by all personnel working around the machine.

APPENDIX B

ATTENTION TO ALL PERSONS WORKING WITH OR AROUND THE ABM MACHINERY AND THE CONSTRUCTION SITE

Assign one qualified, trained and equipped person with authority as SAFETY SUPERVISOR on every job.

Read operator and engine manuals prior to operation of machines and related equipment.

Observe proper safety precautions constantly. The many moving parts can cause serious injury.

Never tow the ABM System with coil stock loaded on the spool.

Use care when working with coil stock. Coils are very heavy and can cause serious injury or equipment damage.

Personnel must always wear gloves to handle coils and panels.

Before starting, walk around machine to assure all is safe. Announce "CLEAR" loudly before starting the engine.

Do not attempt to make adjustments or repairs while the machine is running. Use care that no one starts the machine while it is being worked upon.

Keep fingers clear of gears, rollers and clamps.

Keep control box locked when not in use.

After all adjustments are performed, never operate the machinery with the side or top metal cover panels removed.

After removing run-out tables - SET THE TRANSPORTING RACK UNDER THE MACHINE!

The operator must stay at the control station while forming panels.

As panels are being formed, especially curved panels, an assistant operator is to guide the leading end of the panel to prevent collision with stationary objects such as side rollers.

TO AVOID SERIOUS HAND INJURY - DO NOT PLACE HAND ON ANY PORTION OF THE PANEL THAT CAN COME IN CONTACT WITH A PANEL ROLLER

Never attempt to form panels in winds greater than 20 mph or where the potential for wind gusts exist.

Avoid wearing any loose clothing around machinery and equipment.

Never use any electrical devices when building or ground is wet.

Keep all electrical cords clear of rollers during operation.

Hard hats should be used when overhead work is being performed.

Keep all spectators and non-working persons completely clear of the work area.

Follow safety precautions outlined by the manufacturers' Owners Manual for tools, cords and seaming machines.

Appendix C: Provides a detailed list of test equipment furnished by MIC industries. This list is provided with the purchase of the ABM-240 or the ABM-120 machine.

APPENDIX C

Tools and Test Equipment Furnished *

MANUAL TOOLS LISTED BELOW ARE FURNISHED WITH THE ABM SYSTEM			
1	Tool box w/hinged top and tray	1	Roller chain stretcher
1	16 oz. ball peen hammer	1	Roller chain breaker
1	6" combination pliers	1	8" phillips tip screwdriver
1	Needle nose pliers	1	Aviation type left-handed snips
1	8" standard tip screwdriver	1	Aviation type right-handed snips
1	6" standard tip screwdriver	1	10" adjustable wrench
1	Hack saw w/blades	1	15" adjustable wrench
1	Open end wrench set including: 1/4", 5/16", 3/8", 7/16", 1/2", 9/16", 3/4", 13/16", 7/8", 15/16", 1" and 1-1/8" sizes		
1	3/8" square male drive reversible ratchet		
1	3/8" square drive x 6" long extension		
1	3/8" square drive socket wrench set including: 3/8", 7/16", 1/2", 9/16", 5/8", 11/16", and 3/4" sizes		
1	"T" Handle hex key wrench set including: 3/32", 7/64", 1/8", 9/64", 5/32", 3/16", 7/32", 1/4", 5/16" and 3/8" sizes		
1	"L" Handle hex wrench key set including: 3/32" 7/64", 1/8", 9/64", 5/32", 3/16", 7/32", 1/4", 5/16" and 3/8" sizes		
1	0.000" to 1.000" precision micrometer		
1	Feeler gauge marked metric & inch decimal		

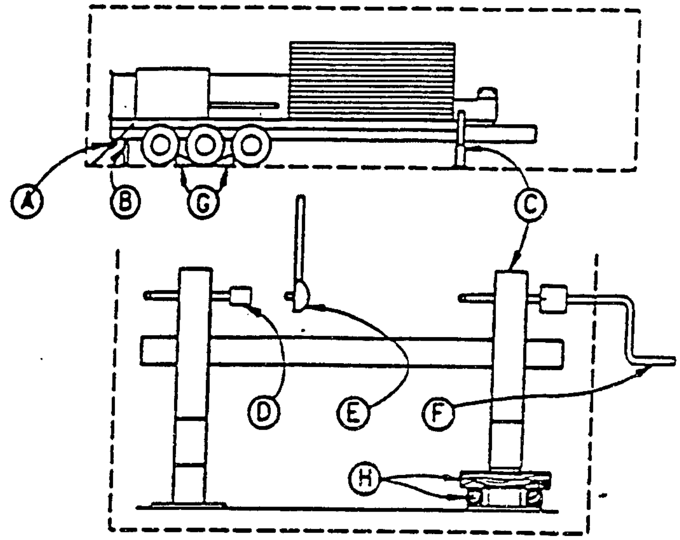
*Note: M.I.C. Industries, Inc., reserves the right to make changes to this list as it deems necessary.

Appendix D: This appendix provides instructions on how to transport the ABM machine in a container. The container is trailer mounted.

APPENDIX D

PROCEDURES FOR UNLOADING AN ABM FROM A CONTAINER

SIDE VIEW



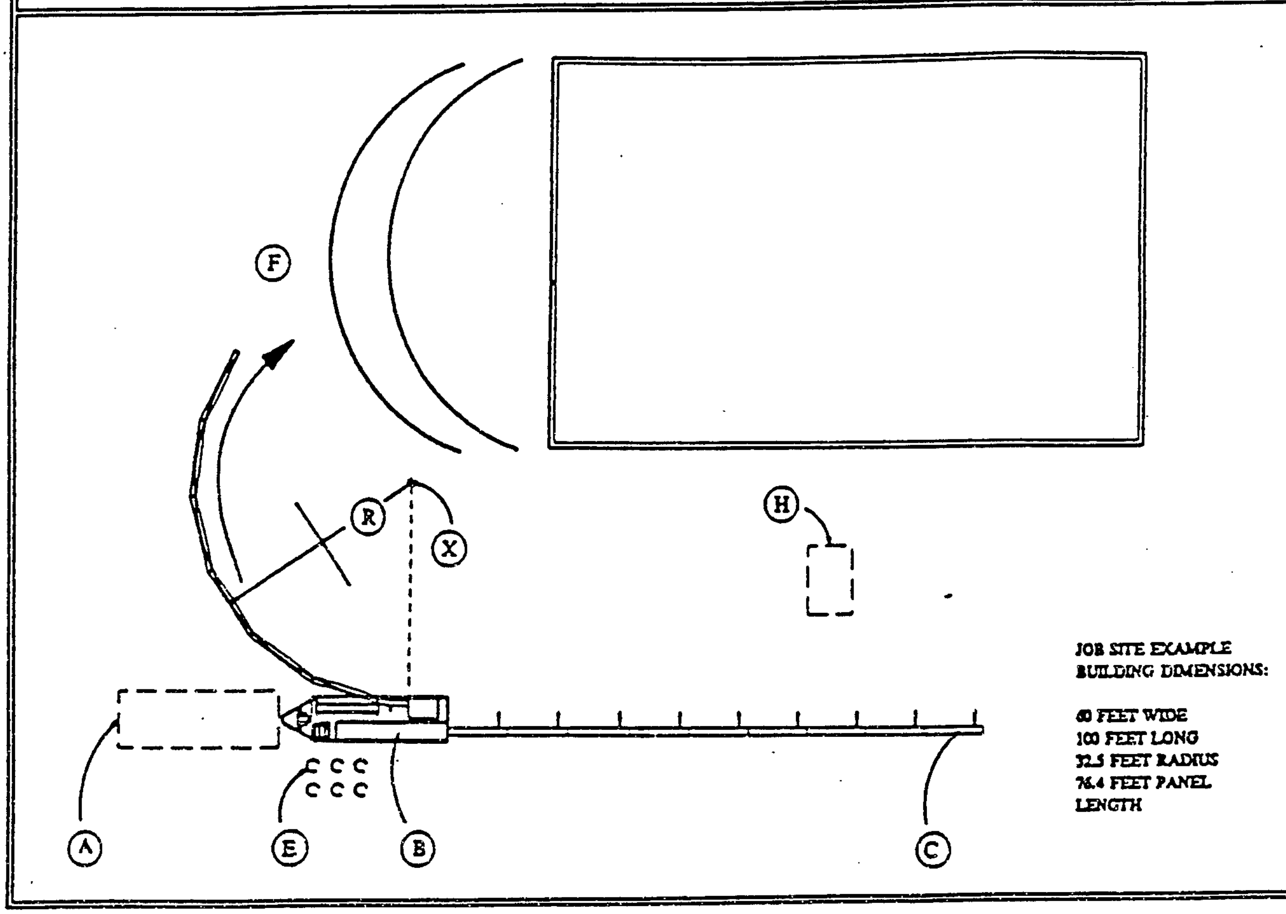
VIEW OF TRAILER FROM CONTAINER DOOR

1. Container must be on level ground or backed up to a loading dock.
2. Remove tie-down turnbuckles (A).
3. Remove cranks (F) from trailer jacks. Using socket and ratchet (D & E), lower front of trailer and remove stands (B) from under rear of trailer frame.
4. Pull nails and remove front blocks (H).
5. Pull nails and remove wheel chocks (G).
6. Connect towing vehicle to trailer. If this is not possible, spread grease on container floor in front of jacks (C) and pull trailer forward until towing vehicle can be connected. (Failure to use grease will result in damage to jacks.)
7. SLOWLY pull unit from container, using care that nothing gets caught on container. Use ramp under wheels if necessary.
8. Attach cranks (F) to trailer jacks for future use.

Apendix E: Provides information on machinery placement calculations, determining the center of curvature, and radius point for the curved panels

APPENDIX E

JOB SITE EXAMPLE BUILDING LAYOUT



Pre-plan job site layout to avoid set-up problems. All of the following must be considered:

LEVEL: If ground is uneven or sloped, align bed of trailer to correspond with general lay of the land. Avoid twis trailer bed as this can cause several operational problems. One or two hydraulic jacks under the rear of the trailer "I" beams may occasionally be necessary.

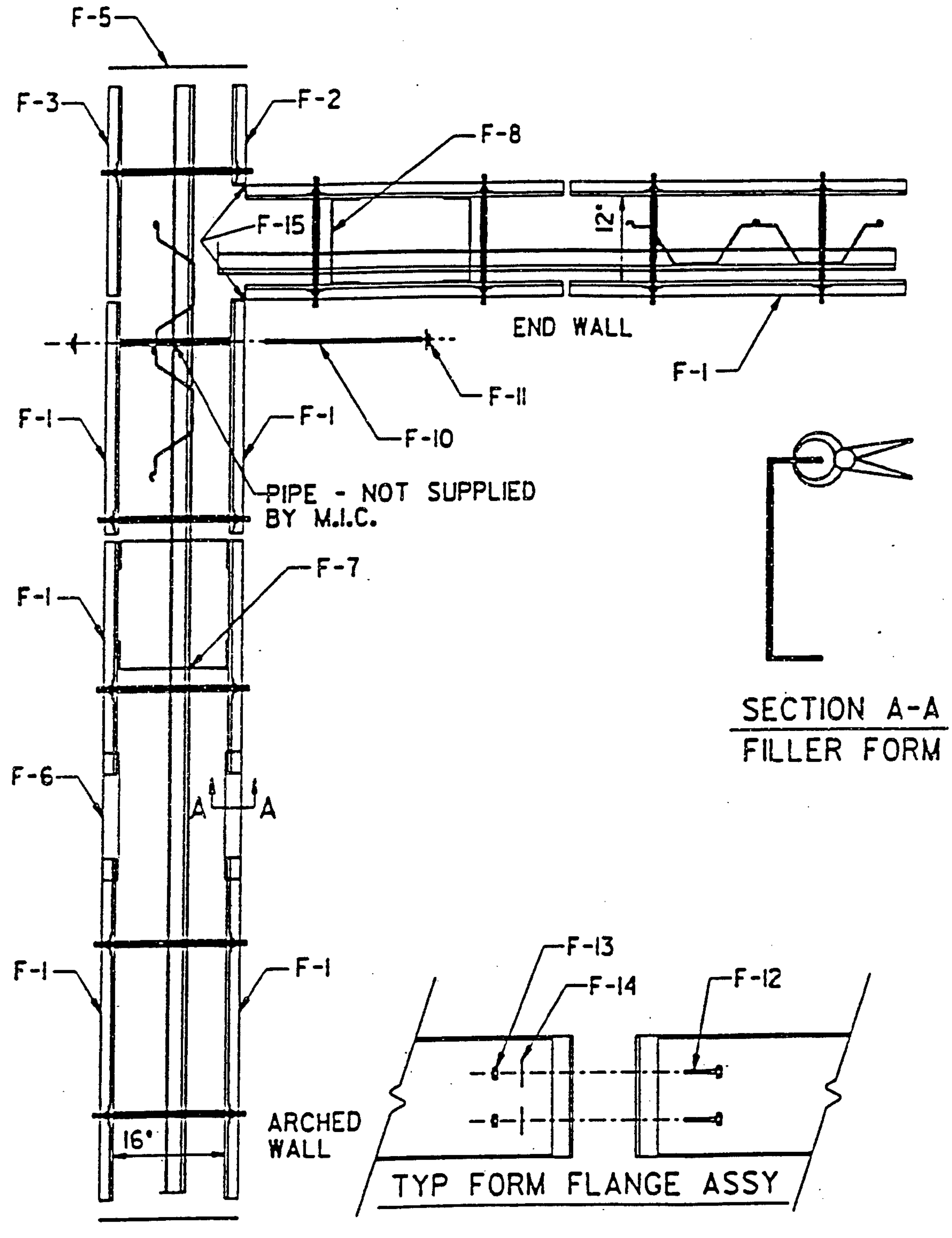
A. Allow room to maneuver towing vehicle or plan to leave it attached to trailer.
B. ABM System is 35' 7" long by 7'6" wide.
C. From rear of trailer, allow room for enough run-out stands to hold straight panel length. Stands have a net length of 9'6" each.
D. Find point "X": From center of curver, measure distance equal to radius in line with front of curver frame. point "X" scribe an arc equal to radius. This arc will define a path of the curved panels. Allow an additior feet beyond this arc for run-out stands and legs.
E. Need area to store coil stock and access for equipment to load it onto the ABM machine.
F. Curved panels must be carried in this general direction after being formed.
G. Must have level area to lay panels on ground for seaming horizontally stacked curved sections.
H. Need space for crane operation.

Appendix F: shows the set up of a typical foundation for the K-Span building.

Formwork, with ties and angled steel is shown on this appendix.

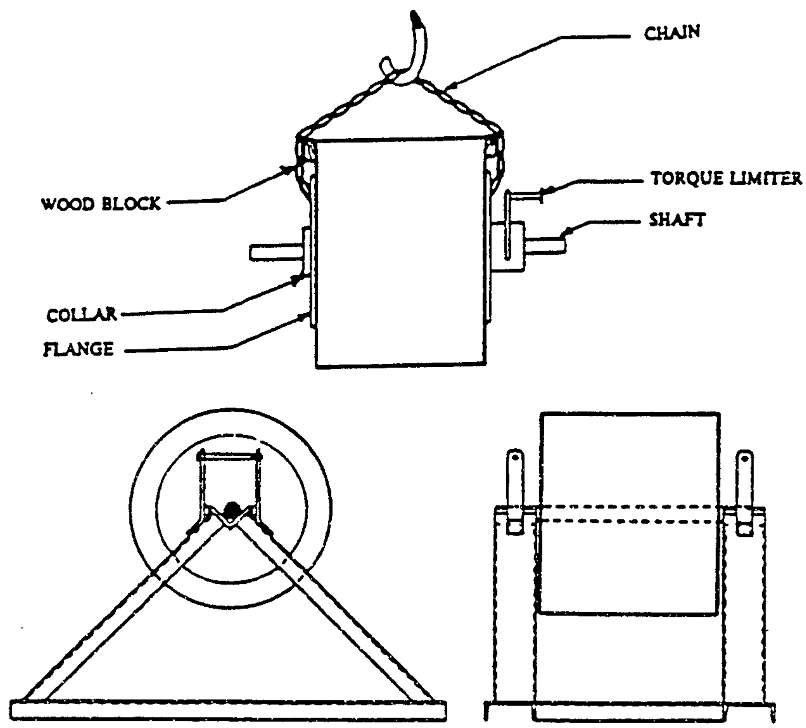
APPENDIX F

ABM SYSTEM CONCRETE FOUNDATION FORMS SETUP



Appendix G: This appendix shows how to load coiled steel stock onto the K-Span machine. Limits on the maximum weight steel, diameters of the steel and much more information is provided.

WARNING
LOADING COILS CAN BE A HAZARDOUS TASK - USE EXTREME CAUTION!



1.) Remove coil reel from the stand on the ABM System.
2.) Back out "Allen " set screw from collar and remove flange from the shaft of the coil reel.
3.) Slide the reel into the opening in the center of the coil.
4.) Replace the flange on the reel and tighten the set screw.

Locate the coil reel near the engine on the ABM System. Remove the reel from the stand. Back out the "Allen" set screw from the collar and remove the flange from the shaft. Slide the reel into the center of a steel coil (coil must be in a horizontal position). Replace the flange over the end of the coil and tighten set screw.

The maximum coil weight allowed is 5,000 pounds. (Heavier coils will not advance through the panel machine.) Any lifting devices with a suitable rated capacity can be used to lift the coil into position on the coil stand: fork lifts, wreckers, cranes or commercial coil lifting devices.

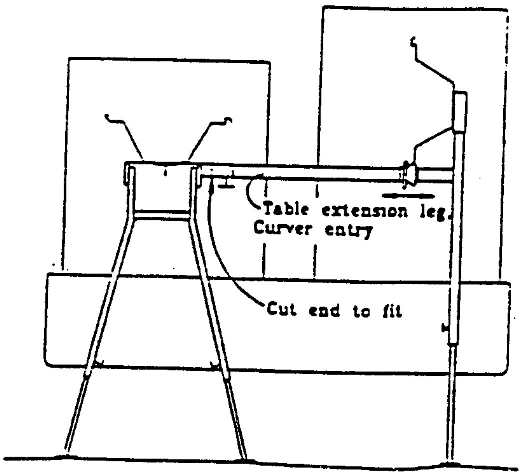
When using a chain or steel cable to lift the coil, place wood blocks on either side of the coil, as shown in the illustration above, to prevent damage to the steel.

Always maintain a minimum inside diameter of 20" round shape on all coils to allow the reel to fit inside the coils.

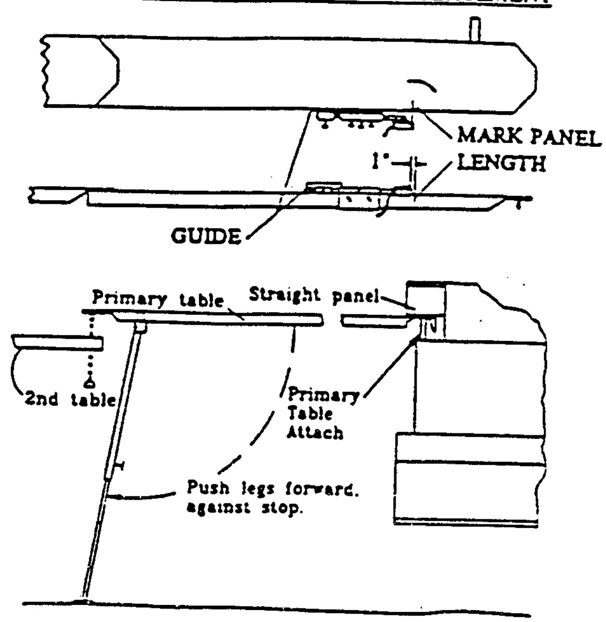
Appendix H: Provides information on the straight panel run out tables. This table list how many tables are providede with the K-Span machine, and also how to set up the tables.

APPENDIX H

RUN-OUT STAND SET-UP AT REAR OF TRAILER



AUTOMATIC MEASURE LIMIT SWITCH PLACEMENT



This project requires four persons: Supervisor, Machine Operator & Minimum of Two Helpers

1.) Attach primary stand, (set two studs in receptacles) leave it sloping slightly downward.
2.) Form approximately 12' of straight panel at slow speed and stop the operation.
3.) Supervisor should stand at end of formed panel, facing machine. With one hand on each side of panel, hold bottom of panel approximately level - direct helpers as follows:
4.) One helper on each side of table, lift it to touch panel bottom, loosen wing bolts, push legs forward against stop, push pads down firmly and tighten wing bolts snugly.
5.) Attach second panel, screw the wing nuts tightly, slope the panel slightly downward and form approximately 10' more of panel.
6.) Adjust second panel same as first table. Supervisor must be sure table isn't rotated out of line or pushing upward on panel (common error). Tighten wing bolts snugly.
7.) Attach third table, form 10' more of panel, adjust table.
8.) Repeat until last table is attached.
9.) Measure, mark table, attach limit switch assembly (see Section 4E6).
10.) Form panel on high speed until stopped by limit switch, adjust last table and limit switch.
11.) Sight back along panel, it should not appear to curve up or down. If it does, adjust tables to correct.

TABLE EXTENSION LEGS - CURVER ENTRY

1.) Attach to straight panel tables, adjust until approximately level, then tighten the wing bolts.
2.) Position straight panel in front of curver entry, turn onto its side and slide into entry guide.
3.) Adjust legs to proper height for equal support of panel and tighten hand bolts.
4.) Check for proper alignment regularly during operation.

Appendix I: This appendix provides a list oftables on how to determine the requirements for the K-Span machine. The set up of run out tables, design data and automatic measuring stops.

APPENDIX I

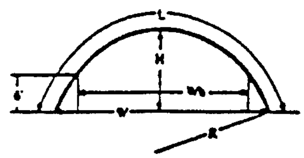
PANEL LENGTH CAN BE FOUND
ON DESIGN DATA TABLES

3 DESIGNING BASIC STRUCTURES

3.1 Sample DESIGN DATA Tables

DESIGN DATA
KIC-240

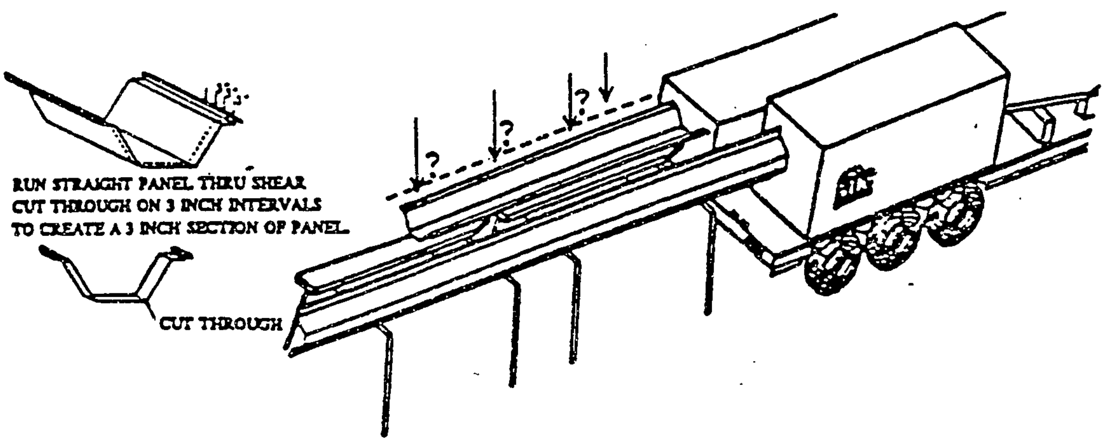
W = 60.0 feet
H = 20.0 feet



L = 76.4 feet
Wh = 53.4 feet
R = 32.5 feet
A = 867 sq ft
(end wall area)

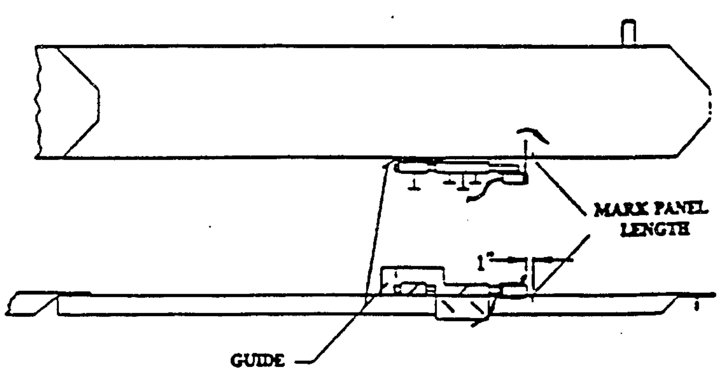
LOADS		STEEL REQUIRED		MAX. FORCES IN ARCH		MAX. ARCH REAC… AT
LIVE	WIND	THICKNESS & GRADE		AXIAL	MOMENT	HORIZ…
		TOP	END			

MARKING RUNOUT TABLES AND FABRICATING PANEL HANGER BRACKETS



Determine panel center and hanger locations. Mark runout tables to insure all clips line-up inside finished building. Use this method to mark location of lifting points as well.

AUTOMATIC MEASURE LIMIT SWITCH



Hold every panel against panel guide - Check length and form all panels at high speed
Turn panel control off before cutting to prevent auto start

Appendix J: This appendix provides an example detailing the steps to take in order to determine the grade steel for top or curved part of the K-Span and also the endless. It also demonstrates how to use the design data listed in appendix V.

APPENDIX J

To use an example, take an example, take a building 76 feet wide, 20 feet high and 100 feet long with 30 pounds per square foot of design live load and 90 miles per hour wind velocity.

a. Choose the table showing "W = 76.0 feet, H = 20.0 feet" in the upper corner.

b. Go down the table under "Loads" until you reach 30 under "live" and 90 under "wind".

c. Reading across, find that the "top" (roof) requires steel .045 inches thick, grade D (50,000 pounds per square inch yield strength). The end walls require only .029 inch grade C (40,000 pounds per square inch yield strength).

d. Go to the bottom of the page and look under ".045" and find that an arch (two feet wide) weighs 492 pounds. The "top" (roof), being 100 feet long, would thus weigh 50 x 492 pounds or 24,600 pounds.

e. Look under ".029" and find that an end wall weighs 1,896 pounds. Two end walls weigh 3,792 pounds.

f. The total building, therefore, weighs 24,600 pounds (roof) plus 3,792 pounds (end walls) or 28,392 pounds.

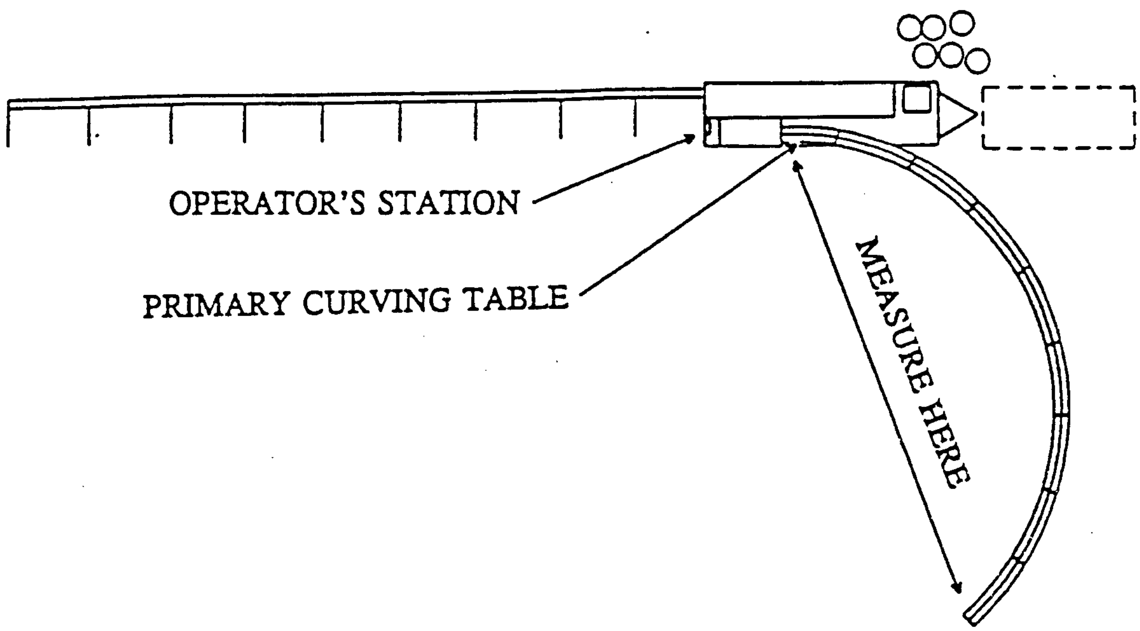
g. Going back to the main part of the table for live and wind loads, extract design data for the foundations (e.g., 1,051 pounds per foot horizontal reaction) for the use of the foundation designer.

It should be noted that these tables also give information necessary for the proper setting on the ABM equipment during construction. For example, using the same 76 foot x 20 foot table, the straight panels should be cut to a length of 89.3 feet and then be curved to a radius of 46.1 feet (see upper right corner).

W_h ("headroom" width for a person 6 feet tall) may also be useful. Other headroom widths may be calculated for the same geometry using the Pythagorean Theorem.

Appendix K: This appendix shows how to fabricate curve panels using the K-Span machine. It also list safety precautions to observe such as the wearing of gloves to prevent the sharp edges of the coil steel stock form cutting hands and fingers, and also to prevent hands and fingers from getting caught in the rollers of the machine.

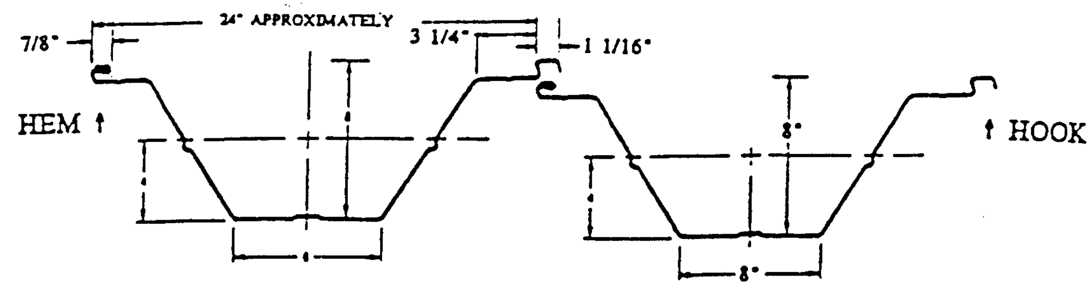
APPENDIX K

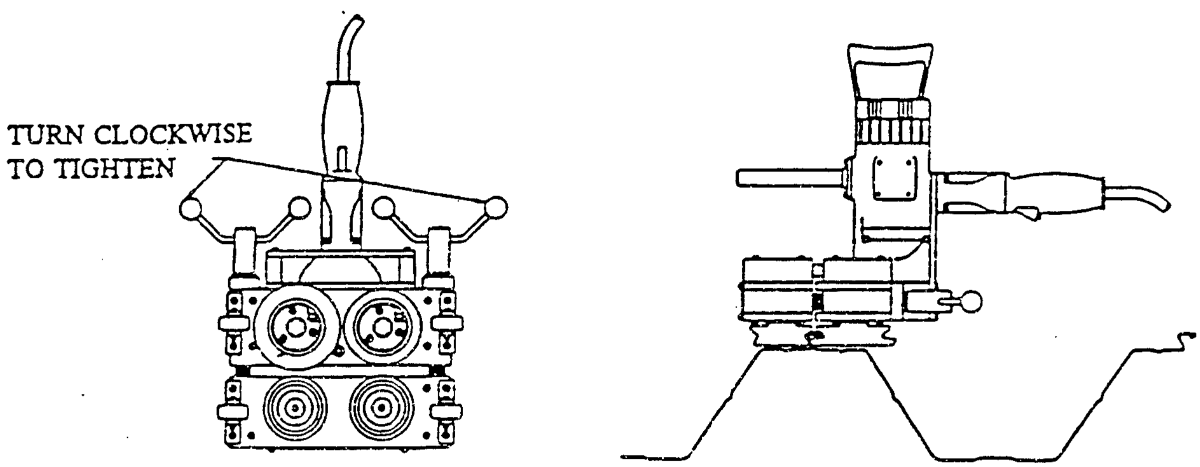
FABRICATING CURVED PANELS	
	
1.)	Operator must remain at the controls while panels are formed and observe supervisor at all times during set-up.
2.)	Align trailer with sloped site or table legs may not be long enough to level tables.
3.)	Form and curve all panels on HIGH speed, even when setting up stands.
4.)	Curver primary table roller needs approx. 1/2" clearance from panel. All other rollers must touch panel flange to maintain the proper radius desired.
5.)	Helper must GUIDE every curved panel around run-out tables. Wind, vibrations and coil stock variations may cause slight radius difference resulting in collision with side rollers if unattended.
CAUTION ALL WORKERS ARE TO WEAR GLOVES AND KEEP THEIR HANDS FROM BETWEEN PANEL AND ROLLERS TO PREVENT INJURIES TO FINGERS AND HANDS.	
6.)	Measure end-to-end of first curved panel and compare it to foundation width prior to removing panel from the stands. Slight variations are to be expected and are acceptable.
7.)	The number of workers necessary to manually transport the curved panel from the tables to the pre-assembly area can be calculated by dividing the panel weight by 50 pounds.
	The formed arch weight for this example building is 327 pounds (as shown on the DESIGN DATA Tables) divided by 50 pounds per person = 7 workers required to safely move.

Appendix L: This appendix provides information on the detail seaming operation. The seamer is one of the areas of danger when working with this machine. There is also information on the type of seam that is performed by the seamer, and problem areas with seaming too tightly.

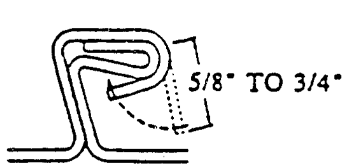
APPENDIX L

BASIC PRINCIPLES OF SEAMING MACHINE OPERATION

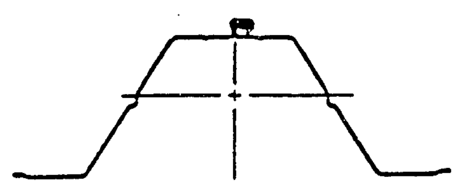




R-240 SEAMING MACHINE



SEAM CLOSEUP



TWO PANELS SEAMED TOGETHER

Adjust seam tightness by turning handle clockwise. Adjust both sides evenly. Adjusting too tight will result in unnecessary strain on bearings and drive mechanism, especially the motor. The seam design of this panel does not require tight contact between panels to be structurally strong. Extra weather protection can be obtained by applying sealant to the inside of the "HOOK" before seaming.

Appendix M: This appendix provides information on the Panel lifting operation. It details how to attach the rigging devices so the crane can hoist the panels into position.

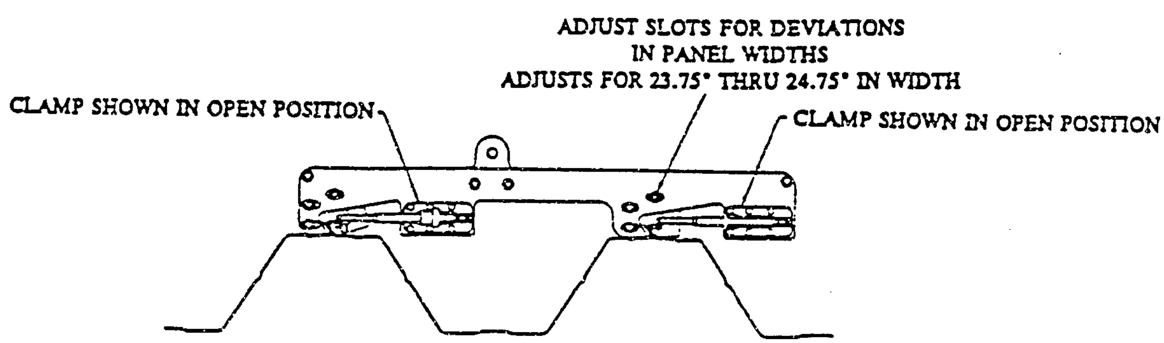
APPENDIX M

Panel Lifting

Check the crane manufacturer's lifting chart for maximum weight capacity and boom extension. The Data Manual section of this manual (as illustrated on page 4-27) will indicate the weight of each arch. Set up the crane location that will safely handle these load conditions. Normally, no more than three (3) MIC-240 ABM System produced arches are lifted as a section at once. It is very difficult to manually stack more than three panels, one on top of each other since three panels equal approximately 6 feet in height. Attempting to stack more than three can be very dangerous.

The panel sections are to be prepared for lifting by the crane using the shackle clamps provided with the ABM System. Review the illustration below for proper attachment.

MIC-240 SPREADER CLAMP
PANEL LIFTING DEVICE

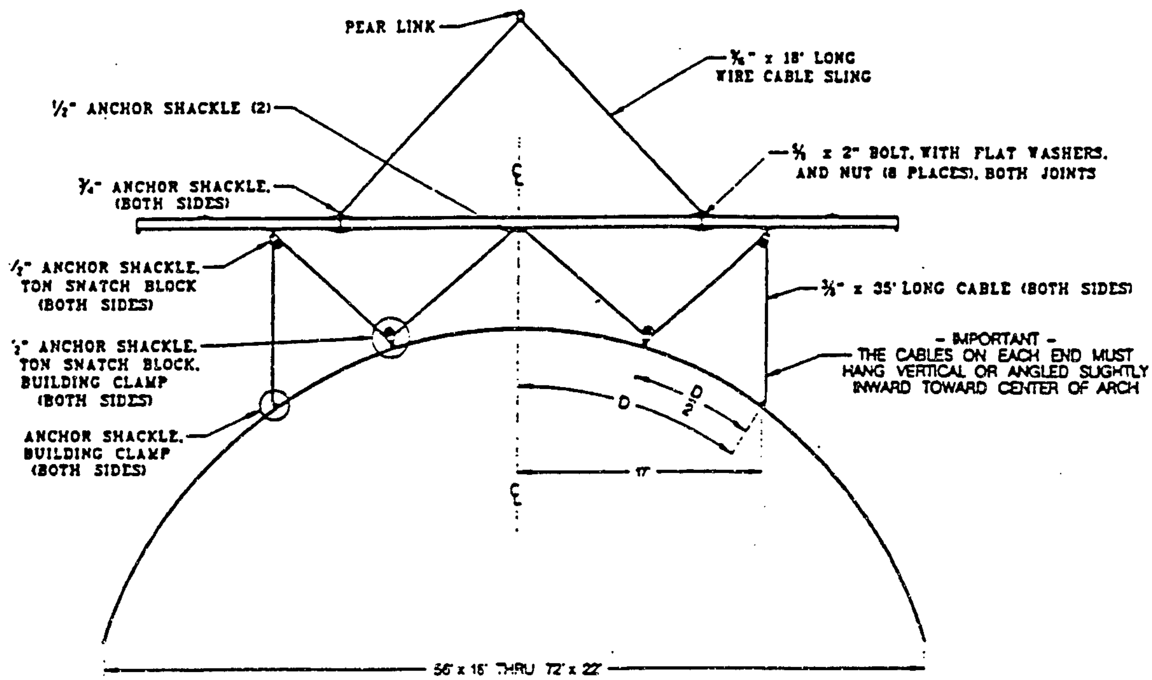


Appendix N: This appendix shows how the hoisting operation is conducted. The placement of the rigging devices and how much weight is positioned in critical places is provided.

APPENDIX N

WARNING
DO NOT ATTEMPT THIS OPERATION WITH WINDS IN EXCESS OF 20 M.P.H.

RIGGING DIAGRAM MID-SIZE BUILDINGS

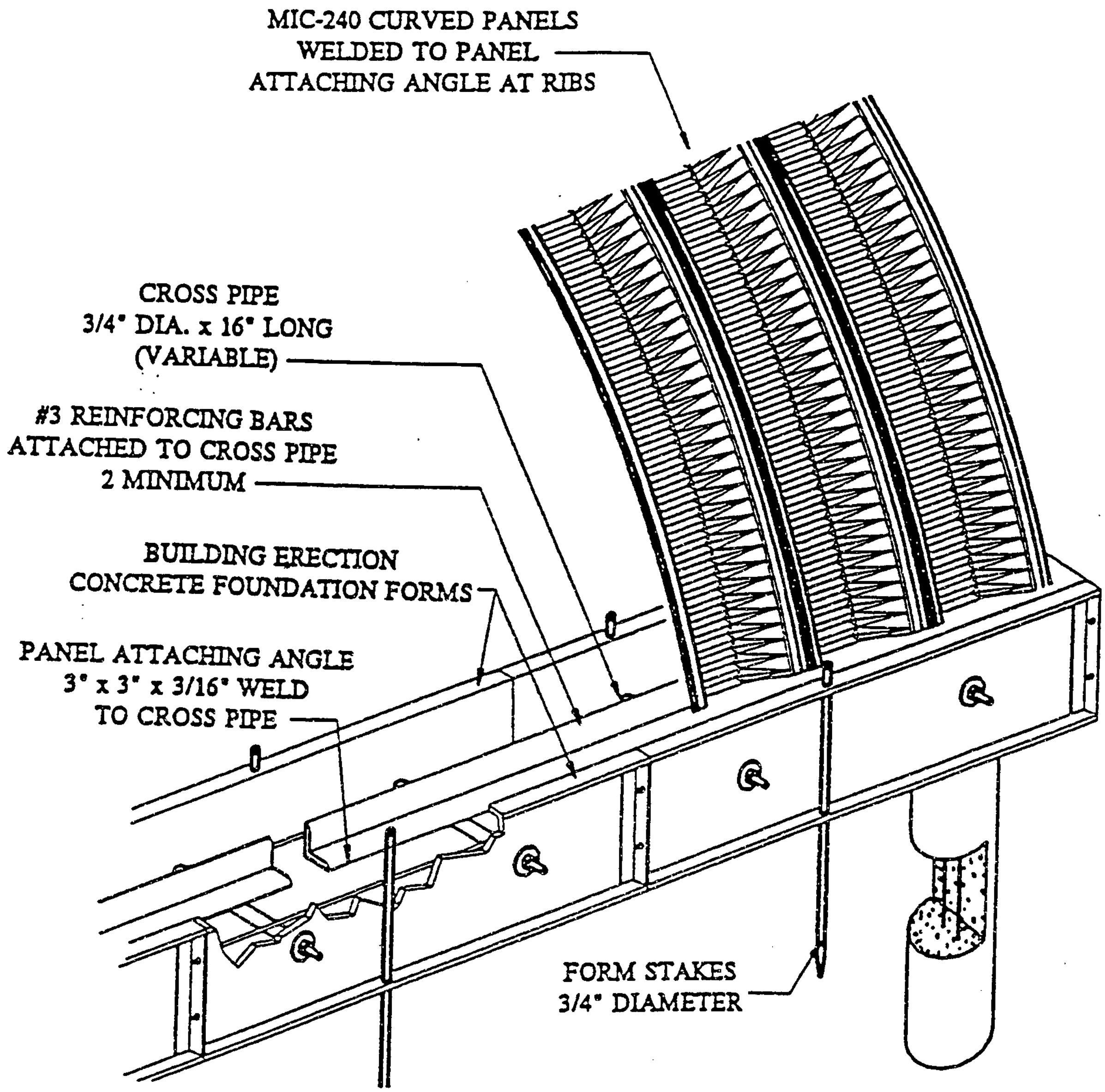


It is very important that when the panel section is being lifted, the spreader bar be positioned directly above the apex of the arch. The cables attaching the shackle clamps must hang in a vertical position at a location not wider than the spreader bar length.

The crane operator is to lift the panels slowly until the arch clears the ground. Position two workers on each free end of the arches with tag lines to keep the section from turning unattended. Lift arches only as high as necessary and instruct workers to keep from standing under ends of the arches. The crane operator must "walk" the lifting bar and the section of arches at a slow but steady pace. The ground crew must not force, bend or twist the arches while they are in the air. They are only to stabilize the sections while the crane does the work. Forcing the section may cause twisting and kinking in the panels. Severe kinks in the section can cause the arches to collapse and cause injury to workers on the ground and loss of materials.

Appendix O: This appendix shows how the first set of panels are placed on the foundation and what goes into the foundation. It also details the caisson holes, the formwork and the angle steel.

PLACING THE FIRST SET OF PANELS IN THE FOUNDATION FORMS

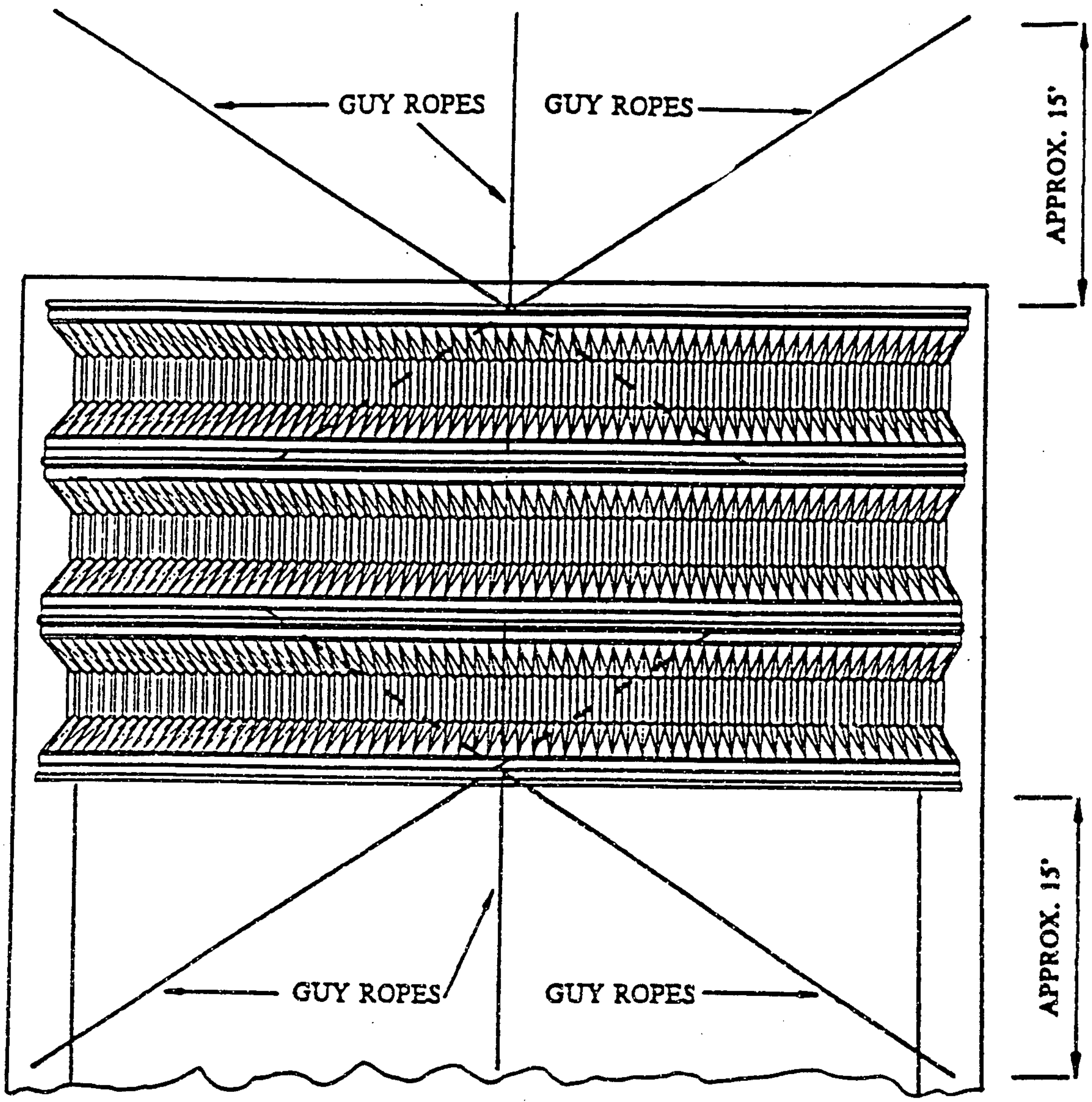


Gently place the panel section on the foundation with the arches resting in the angle iron (base angle) on each side. The first panel section must be measured against the end using a plumb bob suspended from center of the panel arch down to the finish floor elevation. The plumb bob is to intersect with a string line stretched from edge of sidewall to edge of opposite sidewall. Cross measure across the base of the panel section to assure the set is square. The care given to plumbing and squaring the first set will greatly pay off in setting the balance of the building. Weld each panel securely to the angle iron.

Appendix P: This appendix shows how the sections of panels are seamed together on the foundation.

APPENDIX P

OVERHEAD VIEW OF GUY ROPE DETAIL



ATTACH GUY ROPES TO FIRST SET OF PANELS ERECTED

Once this first section is in the correct position it must be firmly secured with guy ropes attached to anchors in the ground and/or on the concrete slab. Unused coils of steel can make good temporary weights to secure the guy ropes. Do not tie the guy ropes to any sharp objects such as hangers that have been torched to create a hole for attachment. These sharp edges can fray or cut the ropes and allow the structure to be unsecured.

Appendix Q: This appendix shows how the endwalls are put together and attached to the curve sides. If there is an opening for a roll up door, then this appendix also shows how to construct the endwalls with the opening.

ENDWALL CONSTRUCTION

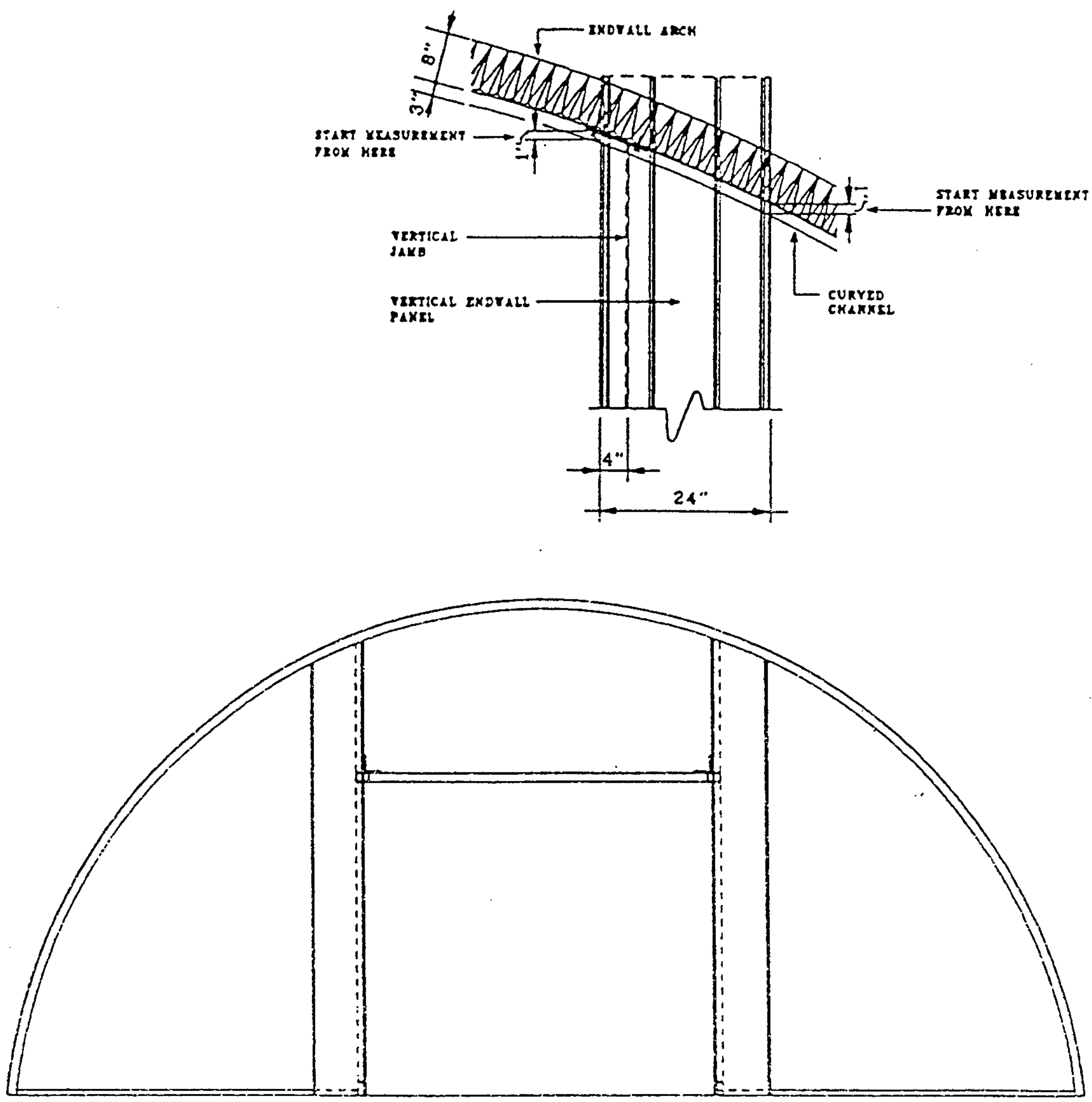


Figure 53

As illustrated above and on page 4-52 Figure 49, the first endwall panels to be installed are the ones adjacent to large framed openings. The vertical edge of the panel is to be flush with the inside edge of the vertical framed opening jamb. Do not attach panels above the framed openings at this time.

IT IS IMPERATIVE THAT ALL ENDWALL PANELS BE CHECKED WITH A LEVEL FOR VERTICAL ALIGNMENT AND A TAPE MEASURE TO VERIFY EACH PANEL MAINTAINS A TRUE PANEL WIDTH OF 24" IN ORDER TO BE ABLE TO FILL IN OVER ALL FRAMED OPENINGS WITH WHOLE WIDTH PANELS. MISALIGNED PANELS WILL BE VERY NOTICEABLE AND WILL CAUSE DIFFICULTIES WHEN SEAMING THE VERTICAL ENDWALL PANELS TOGETHER.

Appendix R: This appendix shows a picture of how to finish the project.

Concrete being placed on the foundation around the angled steel and on the bottom part of the curved and endwall sides

APPENDIX R

13. Finishing the Project

At this point, all panels are in place and secured to the base angle. The next step is optional. A coat of rubberized paint can be applied to the base area of all panels to a height slightly above anticipated finished concrete levels. This can give added protection to the metal panels being exposed to "green concrete". Remember to treat both inside and outside of the panels.

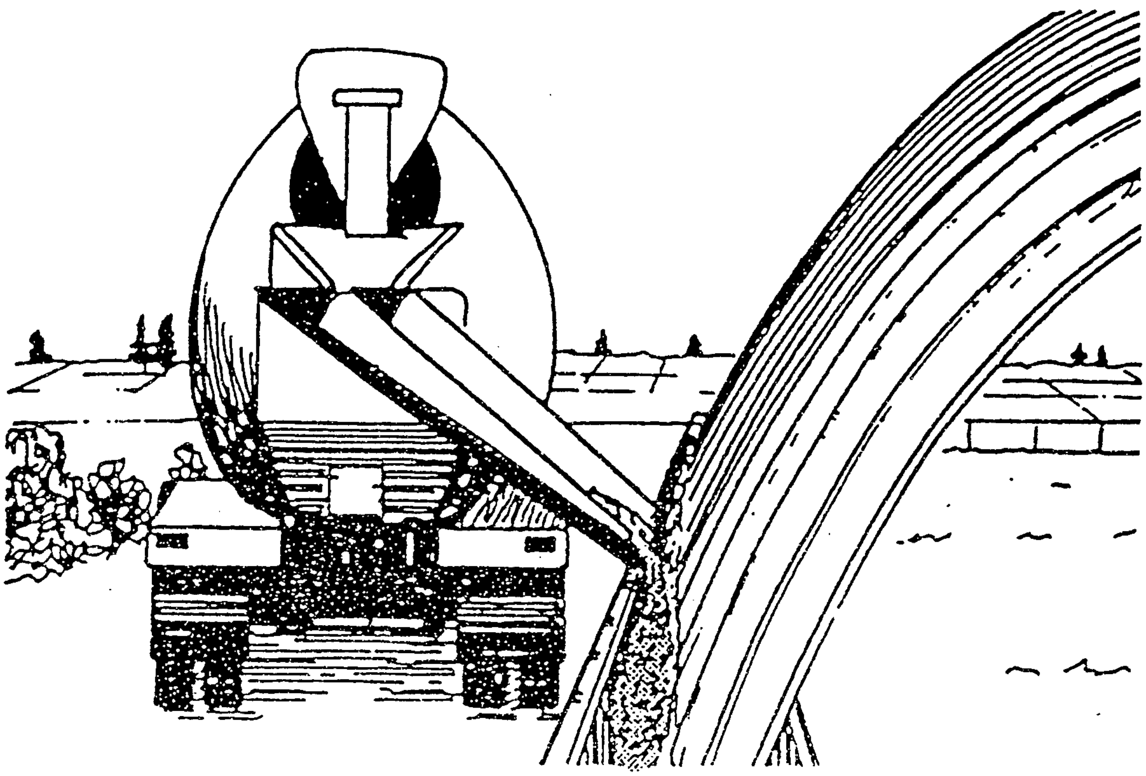


Figure 62

Finally, pour concrete into the above ground foundation forms. Care must be taken to not splash excessive amounts of concrete above the rubberized paint line. One person should be assigned to wipe down the panels above the concrete level before it hardens and becomes too difficult to remove.

Allow the concrete at least 3 to 4 days curing time before removing the forms. Clean forms of all concrete and treat with a lubricant to combat corrosion and store properly for future use.

Police the entire job site to pick up debris. Look for stray tools and equipment.

Appendix S: This appendix shows personnel requirements for construction of the K-Span. The list of all personnel required, and also a caution of using the weight of panels to determine the crew size for lifting and staging the panels.

APPENDIX S

Personnel Requirements

This is a list of personnel required for normal ABM operation and construction accompanied by a brief description of their duties.

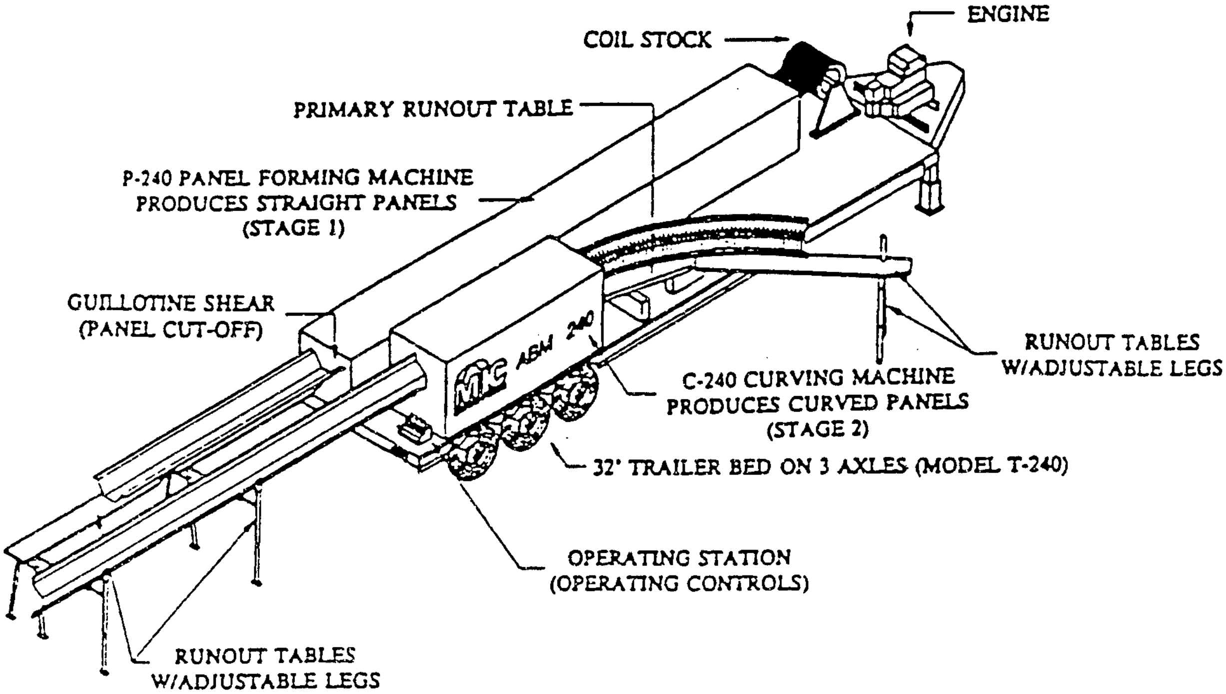
PERSONNEL	SKILL REQUIREMENTS
Engineer	(Not required on a full time basis) Checks all local building codes, base ordinances. Obtains soil tests and building permits where required. May be required to design and engineer foundation and special applications.
Job Site Supervisor (Foreman)	Oversee all phases of construction including machinery transportation and operation. Working knowledge of all tools, equipment and building construction. Must also be familiar with the ABM machinery. Know and Enforce all SAFETY rules and regulations.
Truck Crane Operator	Load steel coils onto machine and transporting equipment. Place arched panels on foundation. Tow machinery unit between job sites. Have and maintain a proper operating and driving license that complies with all state and local requirements. Be very SAFETY CONSCIOUS.
Machine Operator/ Mechanic	Successfully undergo special training on ABM machinery. Learn SAFE operation, maintenance and repair. Be mechanically inclined and have working knowledge of hand tools. Be thoroughly familiar with the "OPERATING MANUAL".
Welder	Have a working knowledge of welding, cutting and fabrication of light steel. Able to read and understand blueprints and written instructions. Be familiar with welder/generator operation and maintenance.
General Laborer	These persons should be familiar enough with construction to be able to follow general instructions with average supervision. They must obey all safety rules and regulations. The job size will determine how many general laborers will be required.

THE WEIGHT OF EACH INDIVIDUAL ARCH AND AVAILABILITY OF PROPER EQUIPMENT WILL ULTIMATELY DETERMINE THE CREW SIZE ON ANY GIVEN ABM SYSTEM PROJECT.

IT IS BETTER TO HAVE ONE OR TWO EXTRA PERSONS AVAILABLE OR ON STANDBY THAN NOT TO HAVE AN ADEQUATE CREW SIZE TO WORK SAFELY AND EFFICIENTLY.

Appendix T: This appendix shows the K-Span machine and the different parts to the machine. Each part is labeled, and the appendix also provides an overview of the capabilities.

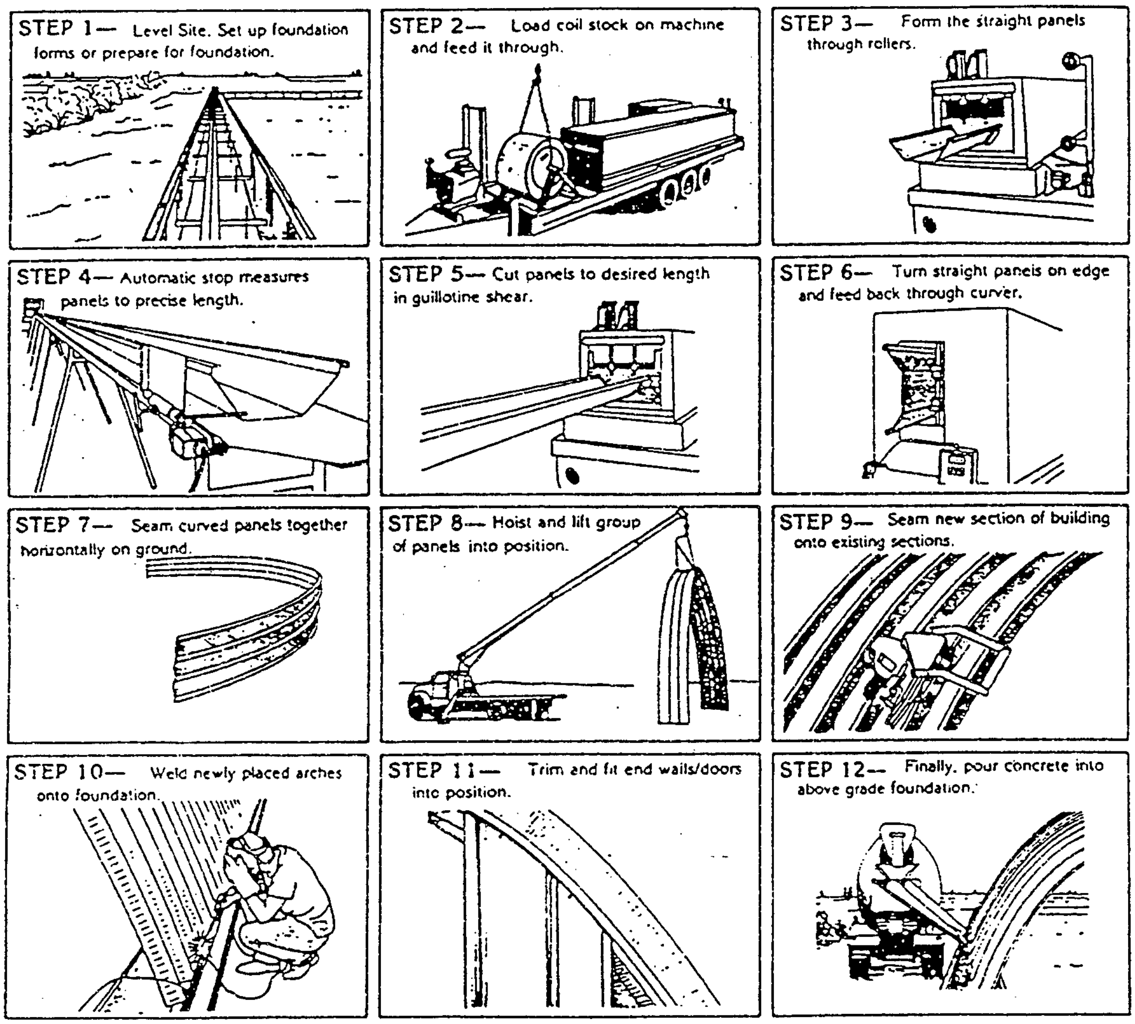
APPENDIX T



ENGINE
COIL STOCK
PRIMARY RUNOUT TABLE
P-240 PANEL FORMING MACHINE
PRODUCES STRAIGHT PANELS
(STAGE 1)
GUILLOTINE SHEAR
(PANEL CUT-OFF)
RUNOUT TABLES
W/ADJUSTABLE LEGS
C-240 CURVING MACHINE
PRODUCES CURVED PANELS
(STAGE 2)
32' TRAILER BED ON 3 AXLES (MODEL T-240)
OPERATING STATION
(OPERATING CONTROLS)
RUNOUT TABLES
W/ADJUSTABLE LEGS

Appendix U: This appendix provides an overview of the entire K-Span construction project. from the foundation to the set up of the machine and finally to the construction and erection of the endwall panels.

APPENDIX U


STEP 1— Level Site. Set up foundation forms or prepare for foundation.
STEP 2— Load coil stock on machine and feed it through.
STEP 3— Form the straight panels through rollers.
STEP 4— Automatic stop measures panels to precise length.
STEP 5— Cut panels to desired length in guillotine shear.
STEP 6— Turn straight panels on edge and feed back through curver.
STEP 7— Seam curved panels together horizontally on ground.
STEP 8— Hoist and lift group of panels into position.
STEP 9— Seam new section of building onto existing sections.
STEP 10— Weld newly placed arches onto foundation.
STEP 11— Trim and fit end walls/doors into position.
STEP 12— Finally, pour concrete into above grade foundation.

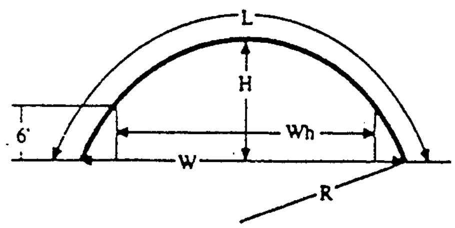
Appendix V: This appendix shows the design data for a building that is 76 feet wide by 89 ft long. The design data for endwall steel gage thickness and curve panel thickness along with the weights of the panels are listed on the design data sheet.

APPENDIX V

DESIGN DATA
MIC-240

W = 76.0 feet

H = 22.0 feet



L = 92.0 feet
Wh = 67.7 feet
R = 43.8 feet
A = 1186 sq ft
(end wall area)

LOADS		STEEL REQUIRED		MAX. FORCES IN ARCH		MAX. ARCH REACTIONS PER FOOT AT FOUNDATION					
LIVE	WIND	THICKNESS & GRADE		AXIAL	MOMENT	HORIZONTAL (LB)		VERTICAL (LB)		MOMENT (IN-LB)	
		TOP	END	(LB)	(IN-LB)	+	-	+	-	+	-
0	70	.035C	.029C	752	-40374	368	-190	283	-98	1077	-20187
0	80	.041C	.029C	1001	-52984	489	-256	380	-115	1262	-26492
0	90	.045D	.035C	1296	-67367	631	-336	495	-126	1385	-33683
0	100	.055D	.035C	1602	-83214	780	-416	613	-154	1693	-41607
10	70	.035C	.029C	-940	-40374	369	-369	283	-318	10908	-20187
10	80	.041C	.029C	1001	-52984	489	-382	380	-335	11097	-26492
10	90	.045D	.035C	1296	-67367	631	-391	495	-346	11219	-33683
10	100	.055D	.035C	1602	-83214	780	-416	613	-374	11529	-41607
20	70	.035D	.029C	-1662	41485	659	-659	283	-537	20740	-20742
20	80	.041C	.029C	-1699	-52984	672	-672	380	-554	20932	-26492
20	90	.045D	.035C	-1724	-67367	681	-681	495	-565	21054	-33683
20	100	.055D	.035C	-1786	-83214	780	-704	613	-594	21365	-41607
30	70	.050D	.029C	-2478	62079	983	-983	251	-799	31033	-31039
30	80	.050D	.029C	-2478	62079	983	-983	361	-799	31033	-31039
30	90	.050D	.035C	-2478	-67102	983	-983	485	-799	31033	-33551
30	100	.055D	.035C	-2509	-83214	994	-994	613	-813	31201	-41607
40	70	.060D	.029C	-3265	82369	1296	-1296	230	-1047	41183	-41184
40	80	.060D	.029C	-3265	82369	1296	-1296	340	-1047	41183	-41184
40	90	.060D	.035C	-3265	82369	1296	-1296	464	-1047	41183	-41184
40	100	.060D	.035C	-3265	-82930	1296	-1296	602	-1047	41183	-41465

STEEL WEIGHTS (LB)						
thickness (inch)	.023	.029	.035	.041	.045	.050
arch weight (lb)	259	326	394	462	507	563
end wall weight (lb)	1671	2107	2543	2979	3269	3633
thickness (inch)	.055	.060				
arch weight (lb)	619	676				
end wall weight (lb)	3996	4359				

REFERENCES

MIC INDUSTRIES, INC 11911 FREEDOM DRIVE, SUITE 1000
RESTON, VIRGINIA 22090 MIC-240 ABM

DAV-LIN CONSTRUCTION COMPANY 6900 PHILLIPS INDUSTRIAL BLVD
JACKSONVILLE FLA. 32241